Issued August 8, 1911.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—CIRCULAR No. 36.
MILTON WHITNEY, Chief of Bureau.

SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XIV.

THE FARGO CLAY LOAM.

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

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THE FARGO CLAY LOAM.

GEOGRAPHICAL DISTRIBUTION.

The Fargo clay loam is an extensive and important type of soil which, because of the mode of its formation, is restricted within rather narrow geographical limits. It is the most extensive single type of soil which has been encountered in the Glacial Lake and Terrace soil province, and a total area of 601,024 acres has been included in six different soil surveys made in the States of Minnesota, North Dakota, and South Dakota. The type owes its origin to the extensive deposition of fine-grained lake sediments in the bed of the old glacial Lake Agassiz, which occupied an extensive territory along the boundaries of the present States of North Dakota and Minnesota. It is also found in the glacial Lake Souris farther west in North Dakota, and in the similar glacial Lakes Dakota, in South Dakota, and Minnesota along the Minnesota River in southern Minnesota. In addition to its occurrence in the beds of these larger extinct glacial lakes, it is encountered in a multitude of smaller glacial lakes within the area of these three States. The type is also known to extend through central Manitoba and eastern Saskatchewan in the Dominion of Canada. In fact, it is probable that the most widespread development of the soil type is to be found north of the Dominion line in these Provinces.

In all of these localities the Fargo clay loam constitutes the great spring-wheat soil of the Northwestern States and the western Canadian Provinces.

CHARACTERISTICS OF SOIL AND SUBSOIL.

The surface soil of the Fargo clay loam is a deep, dark-brown to black clay loam containing a perceptibly large quantity of organic matter. This surface soil has a depth varying from 12 to 24 inches in the various areas where the type is encountered. In the slight depressions found within the type the surface material is often mucky and of an intense black color to a depth of 4 to 8 inches. The subsoil is in all cases a heavy silty clay or clay which not infrequently has a definitely stratified structure. It varies materially in color, dependent

chiefly upon the condition of the subsoil drainage. In the better drained areas it is usually grayish brown or gray or drab, while at greater depths and in localities where the drainage is poor the subsoil is of lighter drab or bluish color.

It is a marked characteristic of the Fargo clay loam, wherever it has been encountered, that the subsoil is highly calcareous. A large number of determinations of calcium carbonate have been made in connection with the study of this soil type, and in the majority of cases the calcium carbonate content of the subsoil of the Fargo clay loam has ranged from 3½ to as high as 24 per cent. This is unusually high when compared with the lime content of other soils and subsoils.

This characteristically calcareous subsoil distinguishes the Fargo clay loam from the black soils of the Clyde series, while the Fargo clay loam is distinguished from the dark-colored soils of the Washburn series, in that the latter contain considerable quantities of stone, while the soils of the Benoit series are underlain by a substratum of gravel. The Fargo clay loam is distinguishable from the Carrington black clay loam through the fact that it occupies the beds of extinct glacial lakes of some size, while the Carrington black clay loam consists of an accumulation of dark-colored surface material overlying glacial till which frequently constitutes the subsoil of that type.

SURFACE FEATURES AND DRAINAGE.

In all areas where it has been encountered the topography of the Fargo clay loam is marked by the almost level character of the land surface. The slopes within the area of this type are usually not greater than 2 or 3 feet to the mile, while the greater proportion of its area possesses a slope not in excess of 1 foot to the mile. In the areas of its broadest development, such as the Red River Valley of the North, the surface of the Fargo clay loam and of its associated types in the Fargo series is generally so level that one is reminded of the surface of a vast body of water, like the sea. In traveling across such regions the surface of the plain is visible only for a distance of 3 or 4 miles. It is bounded by a straight horizon which seems to rise around the position occupied by the observer like the rim of a saucer.

High buildings, such as grain elevators, and the tops of houses and of grain stacks are first visible, and finally the entire structure comes gradually into full view as it is approached. In spite of this almost absolutely level appearance of the surface of the Fargo clay loam, there are minor low undulations and swells interspersed with shallow depressions and broad level areas which give a slight diversity to the surface features of the type, and which aid materially in the natural drainage of a portion of its extent.

The major streams, particularly the Red River of the North, have cut channels into the bed of the extinct glacial lake to a depth of 20

to 50 feet. These are bordered only by a few narrow areas of bottom land, while the banks of the rivers usually rise steeply to the adjoining plain. The tributaries to the major streams also occupy steep-banked channels and are themselves joined by coulées and gullies which constitute the off-flow channels of the surface water. Between the larger drainage lines there often exist areas 5 to 15 miles wide which are unmarked by any water course. The highest parts of these divides are commonly not more than 3 to 5 feet above the lower areas.

In elevation above tide level there is a narrow variation between the different areas occupied by the Fargo clay loam. The lowest points undoubtedly lie along the boundary line between the United States and the Dominion of Canada at an altitude of about 975 feet above tide. The highest altitudes within the area of the Glacial Lake Agassiz rise to about 1,100 feet at its southern termination in the vicinity of Lake Traverse. The altitudes of the smaller areas of the type, in the scattered minor glacial lakes of southern Minnesota and of South Dakota, are quite variable, but usually range from approximately 1,000 feet to less than 1,200 feet above sea level. There is thus a marked uniformity in altitude and in the surface topography of all portions of the type, with very little pronounced relief and with practically no change of climatic environment due to differences in altitude or topography.

The drainage of the Fargo clay loam is frequently defective. The natural drainage is well established only in the immediate vicinity of the water courses and upon the crests of undulating divides between these courses. The broad stretches of nearly level prairie which occupy a considerable proportion of the territory covered by the Fargo clay loam are decidedly defective in drainage, not only because of their level nature and infrequency of water courses, but also because of the stiff, moisture-retaining character of both the surface soil and subsoil, accentuated in many instances by abundant accumulations of organic matter through the deep surface soil.

Erosion is not a serious problem over any considerable proportion of the type. It is only along the margins of the deeper cut stream channels and around the head waters of the coulées, which form the principal tributaries, that active erosion is in progress. Nevertheless, some difficulty has been encountered in the establishment of open ditches to perfect the natural drainage of the Fargo clay loam through the deep cutting of drainage waters, accompanied occasionally by the caving of the banks. Slight precautions in the establishment of grades of such ditches and in the protection of the banks of natural drainage ways will be entirely adequate to counteract this tendency.

LIMITATIONS IN USE.

It is probable that the chief restriction upon the agricultural uses of the Fargo clay loam are the limitations of climatic environment and of natural drainage conditions. Otherwise the type is well suited to the growing of the majority of the general farm crops, whose production is favored by the retentive clay loam texture of the surface soil and by the presence of adequate amounts of organic matter.

The greater proportion of the Fargo clay loam is developed in northern areas within which the short growing period of the summer months is inadequate for the production of Indian corn, especially of those varieties which are common to the more southern prairie States. The climatic conditions, coupled with the level character of its surface and the somewhat poorly established natural drainage, also prevent the growing of the winter grain crops, like rye and winter wheat. On the other hand, the summer-grown small-grain crops are produced to unusual advantage upon this type of soil, and it is also an excellent soil for the production of many of the tame grasses.

Because of the fine texture of both the surface soil and subsoil and of the level character of the land, practically no tree fruits find a favorable environment upon the Fargo clay loam.

Thus the type is practically limited through its climatic surroundings, its drainage characteristics, and its textural peculiarities to the production of the summer-grown small grains and to the growing of grasses. Aside from these, flax constitutes one of the most important crops.

IMPROVEMENT IN SOIL EFFICIENCY.

It is probable that no one thing would have so marked an effect in increasing the yields of the crops now grown upon the Fargo clay loam as the installation of proper systems of drainage. The heavy rainfall during the early spring months not infrequently covers the more level portions of the type with a shallow sheet of standing water, which finds egress neither through natural surface drainage channels nor by means of percolation downward through the soil and subsoil.

This prevents the growing of any winter grain crops and interferes with the production of grasses, since both would be smothered by the presence of the standing water. It also necessitates the fall and winter plowing of a considerable proportion of the area of the Fargo clay loam, since the poorly drained areas remain covered by water sufficiently late to prevent spring plowing in time for seeding.

In some instances drainage districts have been formed, both in North Dakota and in Minnesota, and large main drainage ditches have been dug, some of them many miles in length, in order to carry off this surplus water. In a few instances, also, tile drainage systems

have been established tributary to these ditches in order still further to improve the internal drainage of the soil and subsoil. None of these latter installations have been in place for a sufficient period of time to demonstrate fully the beneficial effects of tile drainage for the Fargo clay loam. It may be said, however, that such installation of proper systems of tile, not only on the Fargo clay loam, but also upon other soils of this general class has been demonstrated to be followed by increases in crop yields amounting to 25 or even 50 per cent above the yields secured upon areas not thus treated. The beneficial effect of the tile drain is most evident during seasons of excessive rainfall, when crops are practically ruined upon areas of inadequate drainage, while a fair to a good crop is produced where the open ditches and supplementary systems of tile have been installed. Even in years of normal rainfall, when the undrained soils produce their best yields, the tile-drained fields are also found to produce slightly larger crops, even though the yields are not so markedly superior as in years of heavy precipitation.

Even smaller increases in crop production than those which have been obtained through the tile drainage of the Fargo clay loam are sufficient to pay a very high rate of interest upon the investment involved. The additional consideration should also be held in mind, that not only does tile drainage increase the crop year after year, but in years of unusually heavy rainfall drainage alone makes the production of any crop possible. The drainage of the Fargo clay loam through the installation of tile is still in its initial stages, and there remain a number of engineering problems to be solved with regard to the best depth for the laying of the tile, the size of the tile to be installed, and the frequency of interval at which the tile lines are to be laid. The systems already installed have also developed the fact that in certain instances the seemingly homogenous subsoil material undoubtedly possesses local variations in the deeper subsoil which give rise to inequalities of drainage not evident from any consideration of surface slopes, or from the consideration of the texture of the surface soil and shallow subsoil. Thus the adequate drainage of the Fargo clay loam constitutes an intricate and difficult problem for the drainage engineer, but a problem which is of vast importance in the more diversified and more profitable occupation of very extensive areas of this type.

Second only in importance to the perfection of drainage systems upon the Fargo clay loam is the adoption of proper systems of crop rotation. The wonderful natural fertility of this soil, its broad expanse of level area, and its climatic surroundings all tended to lead the pioneer farmer toward the adoption of a single small-grain crop, spring wheat. In the earlier days this crop was seeded over areas measured by the square mile, and was produced year after year

without the interposition of any other crop, or even the fallowing of the land between the successive crops of wheat. As a natural and inevitable result, yields began to decline after several years of this system of cropping. Then some variation was brought about through the introduction of flax and the seeding of small areas to the tame grasses. The climatic difficulty attendant upon the production of known varieties of corn prevented the adoption of the more rational crop-rotation systems of the more southern prairie States, and even yet the development of acclimatized varieties of corn of quick maturity has not proceeded sufficiently far to justify the planting of any large acreage of this crop in the more northern regions. As a result there is still a lack of some valuable intertilled crop which may take its place in a rational and systematic crop rotation upon the Fargo clay loam. It is to be hoped that proper varieties of corn may be developed for this latitude, in order that the adoption of this crop as a definite part of the rotation may be made economically possible.

The greater proportion of the Fargo clay loam is adequately supplied with organic matter in the surface soil, although those areas marked by the lighter gray color, together with many square miles of the type which have been exhaustively seeded to wheat for many years in succession, would be decidedly benefited by the application of all available organic manures. The increasing practice of seeding in the tame grasses at some point in the rotation is to be recommended in connection with the maintenance and restoration of organic matter in this soil. In fact, upon those areas where definite crop rotation has been adopted, including the maintenance of a part of the land in grass during a period of each rotation, the yields of grain are being increased and the efficiency of the soil is being improved.

The use of any fertilizer upon this soil has only been attempted in a few localities upon an experimental scale. The use of stable manure is practically unknown, and the need for fertilization of any portion of the type has only been felt within the last few years, after nearly 30 years of occupation for the practically continuous production of one or two different grain crops. The wonderful natural fertility of the Fargo clay loam is as well shown through these circumstances as through the yields of the crops which were produced in the earlier days of its virgin state.

LIMITATIONS UPON SPECIAL CROPS.

The climatic limitation upon the production of crops practically excludes the varieties of corn now known, except for production to a limited degree, particularly for silage purposes. Many other crops are excluded by the same factor of climatic environment. Others are rendered undesirable by the level surface of the soil, by the somewhat obstructed natural drainage, and by the heavy texture of both sur-

face soil and subsoil. Thus the Fargo clay loam can not be ranked as a special crop soil, but takes its place as the dominant spring-wheat soil of the northwestern region.

EXTENT OF OCCUPATION.

Throughout the entire Red River Valley and, in fact, in practically all locations where it occurs nearly every acre of the Fargo clay loam has been occupied for some agricultural purpose. Its level surface, practically uninterrupted even by deeper drainage ways; its treeless prairie condition; and its deep surface soil of marked fertility all led to its rapid occupation for grain production as soon as transportation facilities for the disposal of the crop were provided in the decade from 1870 to 1880. Even those areas which because of their extremely level surface and poorly established drainage have remained in a semiswampy condition are occupied for the grazing of cattle and for the cutting of wild marsh hay. With the increasing demand for land in the general region, attention was turned to the artificial drainage of such areas, and many of them have now been brought under more intensive occupation for the production of grain and the tame grasses. Thus it may be said that practically the entire extent of the Fargo clay loam is now occupied by farms, varying in size from 160 acres to many thousands of acres in the single holding. Any increased development of the type must therefore take the direction of more intensive cultivation rather than of more extensive occupation. Probably 90 per cent of the entire area of the type is now occupied for some agricultural use.

CROP ADAPTATIONS.

Spring wheat exceeds in acreage that of all other crops combined in the extent of its production upon the Fargo clay loam; in fact, it is the one crop of great importance. In the pioneer days the previously unbroken prairie was plowed and sown to wheat. This was the only crop grown, with the exception of a small acreage of oats and barley used to feed the horses kept upon the farm. Taking advantage of the natural productivity of the soil, wheat was grown year after year without either careful preparation of the soil or any crop rotation. In addition to the plowing of the land, which was usually done during the fall and early winter months, the ground was lightly harrowed just before seeding time in spring. In many instances, however, the harrowing was omitted and the wheat was sown directly on the plowed land.

At the present time much the same practice is followed, except that the introduction of improved machinery has permitted deeper breaking of the land, and in practically all cases the soil is harrowed before being seeded to the wheat.

Upon the majority of farms dominated by the Fargo clay loam the gang plow, drawn by 4 to 6 horses, is in common use, while upon all the larger or "bonanza" farms the steam traction engine is used to haul gang plows for the turning of large areas of land each day. Not infrequently the harrow is hitched behind the gang plow when the traction engine is employed for preparing the soil. The grain is then seeded upon the prepared land, and no further attention is required until harvest time.

In harvesting the wheat a considerable diversity of practice exists in the general region and over the area of the Fargo clay loam. Upon the larger farms the header is used, and the grain is thrashed as soon as possible by the use of heavy steam engines and large separators with the stacking blower attached. Upon the smaller farms the grain binder is sometimes used, and the grain is cured in the shock. Generally it is thrashed directly from the shock, although there is an increasing tendency to stack the grain prior to thrashing. The latter practice is growing in favor, since it possesses two principal advantages, in that the cost of thrashing is less and there is less loss of grain. Thrashing is either accomplished by traveling "rigs," or by the use of machinery owned by some local farmer or by a community.

The average wheat yields upon the Fargo clay loam vary to a considerable degree with the amount of rainfall prior to and during the growing season. Whenever the weather conditions are such that a considerable proportion of the plowing for spring wheat has been accomplished during the preceding autumn, large acreages of the crop are seeded and good yields are usually secured. On the other hand, if rainy or other unfavorable weather has prevented, to some degree, the plowing of the usual acreage devoted to wheat, the other small-grain crops replace it to a considerable extent, and if the early spring is, in addition, one of abundant or excessive rainfall, the wheat yields are not infrequently decreased with the complete failure of the crop upon areas of defective natural drainage. It is thus difficult to measure the actual wheat-producing capacity of the soil through a consideration of its yields for any short period of years, and it is impossible to ascertain its efficiency as a spring-wheat soil from the consideration of the yields for a single year. In general it may be said, however, that the average yield of spring wheat upon the Fargo clay loam is about 15 bushels per acre, taking into consideration both wide extent of area and considerable periods of time. The yields range, however, from complete failure, or the production of 5 or 6 bushels per acre under adverse climatic conditions, to yields of 18 and 20 bushels per acre under more favorable circumstances and under somewhat better methods of soil management. Better drainage and the adoption of a regular crop rotation would undoubtedly increase

both the acreage available for spring-wheat production and the average yields per acre.

Next to the acreage of spring wheat that of the wild grasses on the unbroken prairie, occupying areas not sufficiently well drained for crop production, constitutes the principal area, particularly in the Red River Valley. The areas of wild grass are extensively used for the pasturage of beef cattle, to a limited extent for the pasturage of dairy cows, and to a considerable extent for the cutting of wild hay. In practically all locations where poorly drained areas have remained undisturbed since the first occupation of the region the native prairie grasses and the wild marsh grasses still cover the ground. They afford excellent pasturage and a fair hay crop of medium quality, averaging from 1 ton to 1¼ tons per acre in the ordinary season. The existence of these natural grazing areas in conjunction with much larger tracts of arable land would seem to indicate the possibilities of the Fargo clay loam for the establishment of the dairy industry and the production of beef cattle in the general region. In fact, dairying has already gained a foothold upon the farms chiefly occupied by the type in southern Minnesota and in South Dakota. To a limited extent dairying is also being introduced upon the Fargo clay loam in the Red River Valley section. There is an excellent opportunity for its growth and extension.

Among the other crops produced upon the Fargo clay loam the oat crop occupies the largest acreage. Barley is also an important crop. Both oats and barley are frequently used as a catch crop when the weather conditions have been unfavorable for the preparation of the land for spring wheat. In case the land can not be put in shape sufficiently early in the season for the production of that crop, a considerable acreage is then devoted to oats and barley. The yield of oats in all of the areas where the Fargo clay loam has been mapped is fair, ranging from 25 to 40 bushels per acre, with an average yield a little more than 30 bushels per acre. The yield of barley is also good, ranging from 20 to 30 bushels per acre, with an average of about 25 bushels. Flax constitutes another important crop, which is grown principally for the production of seed, although in some localities the fiber is also used. The acreage of flax is usually subordinate to that of oats, although greater than that of barley. For the production of flax new land is usually preferred, and the crop is grown for two or three years in succession until a diminution in yields results. It is then followed by wheat and the other grain crops, while the freshly broken land is taken for the production of flax. The yield per acre is quite variable, ranging from 5 or 6 bushels upon the older land to 12 or 15 bushels upon fresh land, with an average of 10 or 11 bushels per acre for the entire area devoted to this crop.

In all of the more northern locations where the Fargo clay loam is developed the production of corn is entirely subordinate to the growing of other crops. In fact, only a few acres of corn are annually raised in each of the counties where it occurs. The yields reported are low, undoubtedly on account of the varieties which must be grown in order to meet the climatic surroundings of the type, averaging about 25 bushels per acre. In the more southern areas where the growing season is longer, an increasing acreage of corn is being planted each year, and with the development of varieties suited to the climate and the soil, fair success is being attained with the crop. Thus the yields upon the Fargo clay loam in southern Minnesota, in South Dakota, and in the more southern areas in North Dakota average 30 bushels per acre, with not infrequent yields of 35 to 40 bushels. In this connection it is important to state that even where the growing season is inadequate to mature corn for grain production, it is usually sufficiently long to mature the early varieties for use in the silo. Consequently, with the adoption of dairying as one of the more prevalent types of farming in the general section, it would be possible to produce corn upon an increased acreage for silage purposes. This method of development is of unusual importance, since the adoption of a rational crop-rotation system for the Fargo clay loam requires the introduction of an intertilled crop at some point in the rotation, and corn is probably the best hoed crop for such purpose. Under the existing climatic conditions the Fargo clay loam can probably never compete with prairie soils of more southern location in the production of corn for grain, but it is possible to insure a good yield of silage each year for the feeding of both cattle and dairy stock. The additional advantage to be derived from the use of stable manures thus produced would clearly indicate that the more extensive growing of corn for ensilage purposes and for the feeding of stock should be undertaken in the areas largely occupied by the Fargo clay loam and the associated types of the Fargo series.

Irish potatoes are grown to a limited extent upon the Fargo clay loam. The acreage in each of the areas where soil surveys have been made is limited almost entirely to that required for the production of a home supply, and only a small acreage is usually grown upon those farms where the crop is produced at all. The soil type in its normal condition is rather too stiff, too retentive of moisture, and somewhat too difficult to work to constitute a desirable potato soil. In spite of these unfavorable conditions the yields per acre are fair to good, ranging from 85 bushels to 150 bushels or more per acre, with an average in excess of 100 bushels per acre. If the acreage of this crop is to be extended it should be upon the better drained portions of the type and upon such portions as possess the

silty or mucky surface soil, which is more friable and less compact than the general average of the type.

Practically no fruit crops are grown and the type is not well suited to orcharding.

Garden vegetables for home use might be grown much more extensively upon the Fargo clay loam. The early varieties of sweet corn, garden peas, cabbages, lettuce, radishes, and onions are all suited to production upon this type, and upon the more mucky portions the production of cabbages, onions, and celery upon a commercial scale would be easily possible after proper tile drainage had been installed.

Owing to the heavy surface soil and dense subsoil and to the considerable undrained areas of the Fargo clay loam, clover is not entirely successful upon this type. Artificial drainage, successfully installed, would make clover production possible, and excellent crops are now grown upon those portions of the type which are most favored with natural drainage. The principal seeding to tame grasses at the present time is to timothy, usually unmixed with any other species. The calcareous nature of the subsoil would render the Fargo clay loam an admirable type for the production of alsike clover and the medium red clover where drainage was properly provided. The former crop would undoubtedly be successful over the best drained areas of the type as it exists.

FARM EQUIPMENT.

The Fargo clay loam is usually occupied by farms of considerable area. A quarter section of 160 acres constitutes the usual unit in the more closely settled areas, although a few 40's and 80's may be found. In general, however, the single holding amounts to 320 acres or more in the case of the individual farmer, and many farms of 8,000, 10,000, and even 15,000 acres, consisting principally of this type, exist. In some areas, particularly in the more southern region, where the Fargo clay loam is developed, these farms are fenced. In the wheat-growing sections to the northward many of the farms are not fenced at all, or inclosures are only made in the vicinity of the farm buildings. Nearly every farm is improved by a dwelling house and by barns and tool sheds adequate for housing the work stock, the feed for such stock, and the more valuable tools. Horse-power is principally employed in the tillage of this soil. Owing to the large size of the farms, the level surface of the type, and the custom of continuous grain growing, the smallest team usually consists of four horses; the six-horse hitch is not infrequently used. Upon the largest farms both plowing and harrowing are frequently done by the use of the steam traction engine, and upon farms of all sizes, large and small, gang plows are used for turning the soil. With the steam power, heavy harrows of many sections are not infre-

quently hitched behind the gang plow, and both harrowing and plowing are performed at a single operation. Where horsepower is employed the harrow follows the plow with an independent hitch of four to six horses. Seeding is accomplished by horse-drawn seeders, and practically no other tillage of the crop is attempted. The header or grain binder constitutes the principal grain-harvesting machine upon each of the smaller-sized farms, while the larger farms in addition also maintain the thrashing machine with blower attachment. Many steam engines employed for thrashing the grain burn the grain straw as their principal fuel.

Within later years disk plows and disk harrows are to some extent displacing the gang plow and the spike-tooth or spring-tooth harrow.

Upon farms in the more southern areas where the Fargo clay loam has been encountered, dairy barns and dairy equipment are also found, and there is an increasing interest in the development of dairy husbandry. In general, however, the type is devoted to grain growing and preeminently to the production of spring wheat.

SUMMARY.

The Fargo clay loam is the great spring-wheat soil of the Red River Valley of the North and of certain other areas. It has been formed in the beds of extinct glacial lakes.

The surface soil is a dark-gray to black, heavy loam, well supplied with organic matter, and frequently somewhat mucky in character in depressed and poorly drained areas. The subsoil is a stiff partially stratified clay loam which may be either dark-brown, drab, or blue.

The surface of the Fargo clay loam is almost absolutely level over large areas, having a slope of 1 foot to 2 feet to the mile in the majority of cases and an extreme slope of 5 to 6 feet to the mile. Low undulations and swells are separated by broad level areas or slight depressions. The higher lying tracts possess fairly good natural drainage, while the level and depressed areas require the construction of open ditches and the installation of tile drainage to be brought under cultivation.

The altitude of the Fargo clay loam varies from about 975 feet above tide on the Canadian boundary line in the valley of the Red River of the North to altitudes lying between 1,100 and 1,200 feet above tide in the more southern portion of the Red River Valley, and in the separate areas where the type has been developed in other smaller extinct glacial lakes.

The Fargo clay loam is developed under cool temperate conditions of climate which preclude the production of certain general farm crops prevalent upon more southern prairie soils, but which favor the production of good yields of spring wheat of excellent milling quality.

Considerably more than one-half of the total of the cultivated area of the Fargo clay loam is annually devoted to the growing of spring wheat. The yields secured vary considerably with the climatic conditions, principally with the amount of rainfall. In years of excessive rain the yield may fall to an average of 5 or 6 bushels per acre upon the poorly drained areas, while in years of normal rainfall the yield is in the vicinity of 15 bushels per acre for all portions of the type.

Wild hay is second in acreage only to wheat. An average of 1 ton to 1¼ tons per acre is cut under fairly favorable conditions.

Oats and barley constitute important crops to supplement spring wheat, being sown when the climatic conditions are such that the ground may not be prepared in time for the production of the wheat crop. The yields of oats average about 30 bushels per acre; those of barley a little more than 25 bushels per acre.

Owing to adverse climatic conditions only special varieties of corn may be brought to maturity upon the Fargo clay loam, and the yields of these varieties average about 25 bushels per acre. Corn for silage purposes might well be grown upon the type, reaching maturity in the short growing season characteristic of the latitude where the type is developed.

Flax also constitutes an important crop, being grown almost exclusively for the production of seed. The average yield is about 10 bushels per acre. Flax is grown principally upon newly broken ground, while barley by contrast is usually sown upon ground which has produced several crops of wheat or other grain.

Both dairying and stock raising for beef production have gained some foothold upon the type, and dairying in particular might well be developed as a profitable form of farm occupation for the Fargo clay loam.

Heavy teams with the four or six horse hitch and even steam-power machinery are extensively used upon the level surface of the great grain fields constituting the principal tilled area of the type.

Supplementary artificial drainage and the adoption of rational crop rotations are the most important improvements for the management of this soil.

The Fargo clay loam is the dominant spring wheat soil of western Minnesota and eastern North Dakota, being more universally devoted to the production of this crop, it is probable, than any other soil type in the United States.

Approved.

JAMES WILSON,

Secretary of Agriculture.

WASHINGTON, D. C., *June 12, 1911.*

APPENDIX.

The following table shows the extent of the Fargo clay loam in the areas surveyed to this time.

In the first column is stated the particular survey in which the soil was encountered, in the second column its extent of development in acres, and in the third column the volume of the Field Operations of the Bureau of Soils, in which the report upon the area may be found. Those desiring a detailed description of the soil and of the general conditions which surround it in any particular area may consult these volumes in almost any public library.

Areas of the Fargo clay loam encountered in the soil survey.

Survey.	Area of soil.	Year of publication, Field Operations.
Minnesota:	*Acres.*	
Blue Earth County	23,936	1906
Crookston area	320,640	1906
Rice County	24,832	1909
North Dakota:		
Fargo area[1]	74,880	1903
Richland County	113,280	1908
South Dakota:		
Brookings area[1]	43,456	1903

[1] Mapped as Miami black clay loam.